Weed Technology. 2005. Volume 19:346–350

Effects of Halosulfuron on Weed Control in Commercial Honeydew Crops[1]

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Abstract: Studies were conducted at four sites during a 2-yr period in Oklahoma, Texas, and Arkansas to determine effectiveness and safety of halosulfuron in honeydew crops. Halosulfuron applied postemergence at 26.3 to 78.8 g ai/ha controlled yellow nutsedge 85 to 97%, golden crownbeard 100%, and tumble pigweed 83 to 95%. Control of yellow nutsedge continued to increase for 3 to 6 wk after treatment. Golden crownbeard and tumble pigweed efficacy increased to its highest levels after 4 and 3 wk, respectively. Reduced crop growth and yellowing of foliage did not exceed 13%. No differences were recorded for yield, earliness, or percentage of marketable fruit.
Nomenclature: Halosulfuron; golden crownbeard, *Verbesina encelioides* (Cav.) Benth. & Hook. f. ex Gray #[3] VEEEN; tumble pigweed, *Amaranthus albus* L. # AMAAL; yellow nutsedge, *Cyperus esculentus* L. # CYPES; honeydew, *Cucumus melo* L. Inodorus group 'Honeybrew'.
Additional index words: Melon crops, mulch, plasticulture, plastic mulch.
Abbreviations: POST, postemergence; PRE, preemergence; WAT, weeks after treatment.

INTRODUCTION

Weed control is a major concern of cucurbit crop producers. Survey work by Riley et al. (1998) determined that weed competition was a major issue faced by South Central U.S. melon growers. Although weeds can be controlled in cucurbit crops by cultivation early in the season, hand-hoeing is required once vines become prostrate and begin rapid growth (Boyhan et al. 1995). However, costs for hand-hoeing are often prohibitive. Yellow nutsedge is perennial and develops an underground mass of rhizomes and tubers that makes it difficult to control (Fry et al. 1995). Providing for the water and fertility requirements of vegetable crops leads to an ideal environment for rapid nutsedge development (Masiunas et al. 1997). William and Warren (1975) observed a 43% loss in yield in nonweeded plots of cucumber (*Cucumis sativus* L.) with nutsedge infestations. Nutsedge control in commercial cucurbit crops is often limited to cultivation and hand-weeding because few effective herbicides are registered for this crop group (Shrefler et al. 1998). Many other weed species are controlled by covering planting beds with black plastic mulch (Djigma and Diemkouma 1986), but herbicides, cultivation, or hand-hoeing are needed for controlling weeds between the covered plant beds. Nutsedge readily punctures plastic mulch and then competes with crops, rendering plastic mulch ineffective for nutsedge control (Webster et al. 2000).

Tumble pigweed is a serious competitor in cucurbit crops, and its distribution is increasing in southwestern United States (Rushing et al. 1985). Sweat et al. (1998) reported 84% control of tumble pigweed with thifensulfuron at 4.5 g/ha postemergence (POST) and 83% control with the same treatment on Palmer amaranth (*Amaranthus palmeri* S. Wats.). POST control of redroot pigweed (*Amaranthus retroflexus* L.) was 100% for several rates of sulfosulfuron ranging from 37.5 to 112.5 g/ha (Eizenberg et al. 2003). Manley et al. (1996) reported 68 and 85% control of smooth pigweed (*Amaranthus hybridus* L.), respectively, with 4 g/ha of thifensulfuron and 35 g/ha of nicosulfuron POST.

Golden crownbeard is a warm-season annual that is native to the United States (Correll and Johnston 1979). It is found in several southern areas including production areas within Oklahoma and Texas (Grichar and Sestak 1998). Grichar and Sestak (1998) attained 90% or better control of golden crownbeard with bentazon and 2,4-DB and 80% or better control with acifluorfen and pyridate

[1] Received for publication March 19, 2004, and in revised form September 3, 2004.

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[3] Letters following this symbol are a WSSA-approved computer code from *Composite List of Weeds*, Revised 1989. Available only on computer disk from WSSA, 810 East 10th Street, Lawrence, KS 66044-8897.

in peanuts (*Arachis hypogaea*). Golden crownbeard can severely reduce peanut yields (Grichar and Sestak 2000), but little information is available on control of golden crownbeard in cucurbits.

Halosulfuron is a systemic sulfonylurea herbicide (Vencill 2002) being developed for the vegetable crop market.[4] Halosulfuron is registered for several cucurbit crops including cucumber, cantaloupe (*Cucumis melo* L. *Reticulatus* group), honeydew, crenshaw (*Cucumis melo* var. *inodorous*), watermelon (*Citrullus lanatus* L.), pumpkin, and winter squash (*Cucurbita maxima*), but currently, several weed species including golden crownbeard and tumble pigweed are not on the registration. Halosulfuron has both preemergence (PRE) and POST activity on yellow nutsedge and PRE activity on spiny amaranth (*Amaranthus spinosu* L.) and cutleaf groundcherry (*Physalis angulata* L.) (Shrefler et al. 1998; Talbert et al. 1998). Before halosulfuron, yellow and purple nutsedge (*Cyperus rotundus*) control required different herbicides; however, yellow and purple nutsedge are controlled by halosulfuron (Czarnota and Bingham 1997).

The Food Quality Protection Act has caused concern over the potential loss of several herbicides and has prompted the search for new weed control technologies for all vegetable crops (Fennimore and Richard 1999). Therefore, discovery and refinement of new technologies and methods for controlling weeds in commercial vegetable crops is needed. The purpose of these studies was to determine crop safety and effectiveness of halosulfuron when used in honeydew crops on plastic mulch for control of yellow nutsedge, tumble pigweed, and golden crownbeard.

MATERIALS AND METHODS

Study Site Information. Field studies were conducted at four different sites in Oklahoma, Arkansas, and Texas during spring production seasons of 1998 and 2003. A commercial site was used in Texas during 1998, whereas experiment station sites were used in Oklahoma and Arkansas in 2003. Soils at each test site were not altered regarding pH or organic matter before or during studies. Soil at the Texas site was a Runn silty clay (fine, mixed, hyperthermic Vertic Ustochrepts) in Hidalgo County located in the southeast tip of Texas. This soil was characterized by low organic matter level (0.5%) and high pH (8.1). Soils at the Oklahoma sites included a Severn very fine sandy loam (coarse-silty, mixed [calcareous], thermic Typic Udifluvents) at Bixby located in northeast Oklahoma and a Stigler very fine sandy loam (fine, mixed, thermic Aquic Paleudalfs) at Lane located in southeast Oklahoma. These soils had low organic matter (0.8% or less) and pH of 5.9 and 6.2 at Bixby and Lane, respectively. Soil at the northwest Arkansas site was a Captina silt loam (fine-silty, mixed, mesic type Fragiudults) with 1.5% organic matter and a pH of 6.5. The 'Honeybrew' cultivar of honeydew was used in the studies. Native weed populations evaluated were prevalent at test sites except for golden crownbeard at Bixby, OK. This site was direct seeded to golden crownbeard on May 15, 2003, by hand-seeding double rows between plastic-covered, raised soil beds at a seeding rate of $1{,}290 \times 10^3$/ha. Other broadleaf weed species present had sparse populations, and grassy weeds were controlled when needed by graminicides. Test sites for each weed species included: Arkansas and Lane, OK, for yellow nutsedge; Arkansas and Lane, OK, for tumble pigweed; Texas and Bixby, OK, for golden crownbeard.

Field production systems for all experiments included raised soil beds with 2.1 m between bed centers. Bed tops were 0.9 to 1.1 m wide with one row of melons per bed and 30 cm between melon plants. All sites were irrigated with drip tape buried 20 to 25 cm below the soil surface. Black plastic mulch, 1.5 m wide, covered the top of the raised soil beds. Commercial production practices were followed except that plots were not hand-weeded. The Texas site was established by hand-seeding during mid-February, and the Oklahoma and Arkansas sites were hand-seeded between mid-April to mid-May. Holes were punched or burned into plastic mulch, and three honeydew seeds were planted in each hole. Plants were thinned to one per hole after crop emergence.

Experimental Procedure. Each study site was arranged in a randomized complete block design with four replications. Plots consisted of one raised soil bed 6.2 to 7.8 m long. The six treatments included a (1) nontreated weedy check; and halosulfuron applied—(2) once at 26 g/ha, (3) twice at 26 g/ha, (4) once at 39 g/ha, (5) twice at 39 g/ha, and (6) once at 79 g/ha. Nonionic surfactant was added to all halosulfuron treatments at 0.25% v/v. Initial herbicide applications were POST 29 to 35 d after planting. After 13 to 23 d, a second halosulfuron application was made to those treatments requiring two applications. All applications were POST to the crop and weeds and were applied over the top of the crop row, plastic, and bare soil along the bed sides with a CO_2-

[4] Sandea, Gowan Co., 370 South Main Street, P.O. Box 5569, Yuma, AZ 85366.

pressurized four-nozzle hand-boom sprayer[5] calibrated to deliver 249 L/ha at pressures of 124 to 221 kPa. Air temperatures at application ranged from 24 to 29 C. Melon vines had 3 to 10 true leaves at the first application and 8 to 15 at the second application, with more mature vines having immature fruit at the time of the second applications. Nutsedge was 13 to 28 cm in height at the first and second applications, golden crownbeard was 10 to 30 cm in height at both applications, and tumble pigweed was 4 to 10 cm in height at both application times. At the time of applications, yellow nutsedge had penetrated the plastic mulch that covered the plant beds. Golden crownbeard and tumble pigweed were limited to the open soil in the furrows between covered plant beds.

Data Collected and Statistical Analysis. Percent damage to the crop was rated, with 0 representing no crop injury and 100 representing death of the plants. Efficacy for each weed species was rated on a scale, with 0 representing no weed control and 100 representing complete control. Initial ratings were recorded 1 to 2 wk after treatment (WAT) after the first treatment applications and 4 to 6 WAT for final ratings. The number of harvests ranged from six to nine per site to reflect commercial harvesting practices. Yield data included the number and sizes of marketable fruit and number of cull fruit. Fruit were considered mature and ready for harvest on the basis of the loss of pubescence on the fruit surface and fruit color changing from green to a pale yellow. Yield was reported as percent marketable yield and as percent increase compared with the nontreated check. Earliness was defined as the percentage of total marketable yield harvested during the first three harvests. All data were analyzed using analysis of variance. Percentage data were transformed using the arcsine square root transformation. Locations were analyzed as the main plot of a split plot design. There was no location by herbicide treatment interaction for weed control, earliness, and marketable fruit; therefore, they were pooled across locations. All means were separated with Duncan's multiple range test at $P = 0.05$.

RESULTS AND DISCUSSION

Crop Response. Injury to honeydew plants was minimal and ranged from 1 to 13% in the first 2 wk after application (data not shown). Injury included slight stunting of the foliage and yellow spotting of both the foliage and fruit. Yellow spots resulted from herbicide contacting the surfaces of fruit and foliage that were in the field at application. By harvest, yellow spots on the foliage or fruit were not visible and fruit matured normally. Recovery from injury occurred 1 to 2 WAT, and no plant injury was evident 4 wk after the second application of halosulfuron. Miller and Libbey (1999) also reported early injury from halosulfuron on cucurbit crops, with injury declining over time.

Table 1. Control of golden crownbeard, yellow nutsedge, and tumble pigweed with halosulfuron applied postemergence, averaged over two locations.[a,b]

	Weed control[c]					
	Golden crownbeard		Yellow nutsedge		Tumble pigweed	
Halosulfuron rate	2 WAT	4 WAT	3 WAT	6 WAT	3 WAT	6 WAT
g/ha	%					
Nontreated check	0 b	0 b	0 b	0 b	0 b	0 b
26	99 a	100 a	85 a	85 a	83 a	83 a
26 + 26	98 a	100 a	96 a	85 a	95 a	85 a
39	99 a	100 a	97 a	97 a	95 a	94 a
39 + 39	99 a	100 a	97 a	97 a	95 a	95 a
79	97 a	100 a	96 a	97 a	95 a	95 a

[a] Abbreviation: WAT, weeks after treatment.

[b] Locations were Texas 1998 and Bixby, OK, 2003 for golden crownbeard, Lane, OK, 2003 and Arkansas 2003 for yellow nutsedge, and Lane, OK, 2003 and Arkansas 2003 for tumble pigweed.

[c] Means in each column followed by the same letter are not different based on Duncan's multiple range test.

Weed Control. Halosulfuron completely controlled golden crownbeard (Table 1). Response of golden crownbeard to halosulfuron was rapid, with weed terminals browning in 24 to 48 h and complete control within 4 WAT. Control of golden crownbeard is particularly important for non–plastic mulch production systems where competition from this summer annual can severely reduce yields (Grichar and Sestak 2000). However, even in plastic mulch production, golden crownbeard growing between plastic-covered beds needs to be controlled to prevent weed competition for light and interference with harvest operations.

Yellow nutsedge control from halosulfuron ranged from 85 to 97% at 3 and 6 WAT (Table 1). Nelson and Renner (2002) reported 97% control with 35 g/ha of halosulfuron, and Vencill et al. (1995) recorded 95% reduction in shoot regrowth of yellow nutsedge from halosulfuron at 106 g/ha placed below tubers. Nutsedge responses to halosulfuron included foliage yellowing, growth cessation, and plant death over a 3 to 6 wk period. These were similar to responses observed by Van Biljon et al. (1996).

Halosulfuron controlled tumble pigweed 83 to 95%

[5] XRTeeJet 11004 VS, DGTeeJet 11004, DGTeeJet 11015, TeeJet 8003 VS spray nozzles, Spraying Systems Co., P.O. Box 7900, Wheaton, IL 60189-7900.

Table 2. Percent yield increase, compared with nontreated plots, of honeydew melon treated with halosulfuron at four sites.

Halosulfuron rate	Percent yield increase[a,b]			
	Texas 1998	Arkansas 2003	Lane, OK, 2003	Bixby, OK, 2003
g/ha	%			
26	15[b]	17	16	57
26 + 26	13	10	13	0
39	31	34	28	0
39 + 39	11	20	29	0
79	23	26	39	1

[a] Yields in nontreated plots were: 90 Mg/ha, Texas 1998; 70 Mg/ha, Arkansas 2003; 60 Mg/ha, Lane, OK, 2003; 71 Mg/ha, Bixby, OK, 2003 based on conversion of original volume-based yields assuming boxes having a mass of 22.7 kg/box.

[b] Means did not differ significantly at any location ($P > 0.05$).

Table 3. Honeydew melon earliness and percentage of marketable fruit as affected by halosulfuron applied postemergence, averaged over four experiments.[a]

Halosulfuron rate	Earliness[b]	Marketable fruit[c]
g/ha	%	
Nontreated check	36[d]	78[d]
26	33	80
26 + 26	31	79
39	32	80
39 + 39	33	78
79	32	79

[a] Locations were Texas 1998, Bixby, OK, 2003, Lane, OK, 2003, and Arkansas 2003.

[b] Earliness is defined as the percentage of total marketable yield harvested during the first three harvests.

[c] Marketable is defined as the percentage of total yield considered to be marketable.

[d] Means did not differ significantly among treatments ($P > 0.05$).

(Table 1). Umeda (2002) had inconsistent results with halosulfuron applied POST, reporting 44 to 77% control with a rate of 56 g/ha and 33 to 86% control with 112 g/ha. Although his results were not entirely consistent with this study, variability in the control of other amaranth species with halosulfuron POST has been observed to occur when these plants are at later growth stages than those encountered with our studies.

Crop Yields. There were no differences in honeydew yields because of halosulfuron treatments at any location (Table 2). This response was similar to the results of Johnson and Mullinix (2002) in studies that included tank mixtures of halosulfuron and ethalfluralin applied after transplanting of cantaloupe and watermelon through black plastic mulch covered beds. They had yield increases from herbicide treatments of 25 to 105% for cantaloupe and 70 to 320% in watermelon, but had no significant differences in yield. Other investigators have reported tolerance to POST applications of halosulfuron at rates ranging from 20 to 39 g/ha by cantaloupe, which is closely related to honeydew (Buker and Stall 2001). Halosulfuron treatments did not affect melon earliness or the percentage of marketable fruit compared with the nontreated check (Table 3).

Although halosulfuron treatments resulted in early crop injury, honeydew recovered in a short time (1 to 2 wk). The relatively small increase in yields of halosulfuron-treated plots provides evidence that direct-seeded honeydew crops produced with black plastic mulch and drip irrigation can compete successfully with several weed species. Johnson and Mullinix (2002) suggested that black plastic mulch acts as an effective weed control practice for a majority of weeds including pigweed species and annual grasses, but not nutsedge. Furthermore, results from other studies indicate that cucurbits in a rapid state of growth are very competitive with weeds (Monks and Schultheis 1998; Nerson 1989). The black plastic mulch in these studies acted as an effective barrier to penetration and emergence of tumble pigweed and golden crownbeard. This limited these weeds to the open furrows between the covered beds, where they were controlled by halosulfuron. Yellow nutsedge was the only weed species in the studies that was able to penetrate the mulch, but it was also controlled by halosulfuron. On the basis of the results, the authors conclude that halosulfuron will provide a much needed tool for the control of yellow nutsedge, golden crownbeard, and tumble pigweed for commercial honeydew production.

ACKNOWLEDGMENTS

We would like to acknowledge the support and efforts by James Peterson and David LaGrange of Starr Produce, R. L. Dreibelbis of Elmore and Stahl Produce, and technical assistance from Lynda Wells, Bruce Bostian, Juan Bernal, Venancio Gonzalez, Carlos Rodriquez, and Buddy Faulkenberry. Many thanks to Marilyn McClelland and Michel Haigh for reviewing and making editorial suggestions. Many thanks to Martin Parham with Herbiseed, who was instrumental in finding golden crownbeard seed, making it possible to complete work on that weed species. The research in this report was supported by the Oklahoma Agricultural Research Station and funded in part by a grant from the South Texas Melon Committee.

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